Docket No. F-8643

## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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| Applicant | : | Takeshi KUWABARA, et al. |
| Serial No. | : | 10/531,715 |
| Filed | : | April 18, 2005 |
| For | : | SELF-OXIDATION INTERNAL HEATING STEAM REFORMING SYSTEM |
| Group Art Unit | : | 1746 |
| Examiner | : | Matthew J. Merkling |
| Confirmation No. | : | 1453 |
| Customer No. | : | 000028107 |

Commissioner for Patents
P.O. Box 1450
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## DECLARATION UNDER 37 C.F.R § 1.132

I, Takeshi Kuwabara, declare and say:

1) I am a citizen of Japan and reside at 2157-5 Katakura-machi Hachioji-shi Tokyo Japan.

2) I am one of the inventors of U.S. Patent Application Serial No. 10/531,715.

3) I graduated in 1973 with a Ph.D. in electrochemistry from the Tokyo Metropolitan University located in Meguro-ku, Tokyo (such university relocated to Hachioji-shi, Tokyo in 1991).

4) I was employed at Toshiba Corporation from 1973 to 2001, and was involved in the field of technical development of fuel cell power generation. I also took a leadership role in a national project for the improvement in the interface of fuel cell systems and reforming systems.

5) I have been working at T.RAD Co., Ltd. since 2001, and have been engaged in the field of technical development of fuel cell power generation, including having managerial responsibilities for such technical development.

6) I have been granted fifteen patents relating to engineering for fuel cells and nine patents relating to other fields.

7) I am familiar with the invention of U.S. Patent Application Serial No. 10/531,715 and provide the following technical comments regarding such patent application.

**Thermal Effect of Heat Insulating Wall**

The invention of U.S. Patent Application Serial No. 10/531,715 (the '715 application) seeks to address a particular problem, as follows. In the second reaction chamber there is a mixed catalyst bed which contains a steam reforming catalyst and an oxidation catalyst. The reforming reaction in this mixed catalyst bed is an endothermic reaction. Thus, it was desired to reduce the heat dissipation from the mixed catalyst to increase reforming efficiency. On the other hand, the shift catalyst bed in the second reaction chamber exhibits an exothermic reaction and it was desired to increase the heat dissipation to prevent degradation of the shift catalyst. Additionally, the reforming reaction of the steam reforming catalyst bed in the first reaction chamber exhibits an endothermic reaction and it was therefore desired to received an external heat supply. The invention of the '715 application solves this problem by separating the first and second reaction chambers with heat-conductive partition walls except for portions of the partition

walls in contact with the mixed catalyst bed.

In order to determine the effects of insulation, I undertook some experiments to determine the improvement obtained with the use of the insulation around a mixed catalyst bed. APPENDIX I (attached) shows a diagram of the experiment and the parameters involved. A comparison was made between an apparatus with the heat insulating wall and an apparatus without the heat insulating wall. The results of the experimentation are as follows:

The amount of heat transfer/heat radiation from the mixed catalyst bed to the outer cylinder are reduced by the heat insulating wall. Thus, there is a suppression of the decrease in the outlet temperature of the mixed catalyst bed. Thus, the reverse reaction (methanation reaction) of the reforming reaction (hydrogen generation reaction) that is in equilibrium in the mixed catalyst bed was suppressed. Thus, a reduction in the amount of oxidation air was achieved, which suppressed the excess combustion of hydrogen. The methane slip was reduced and the generated amount of hydrogen was increased. The end result of the above situation was the unexpected improvement of thermal efficiency of the entire reformer. The amount of oxidation air needed was reduced and the thermal efficiency of the reformer was increased by 5% from 80% to 85%. The higher the

efficiency in a system, the more difficult it is to obtain further increases in efficiency. Because an 80% efficiency is a relatively high number to begin with, a 5% increase to 85% efficiency is a significant increase in efficiency, especially since such increase in efficiency was obtained by the mere addition of insulating walls.

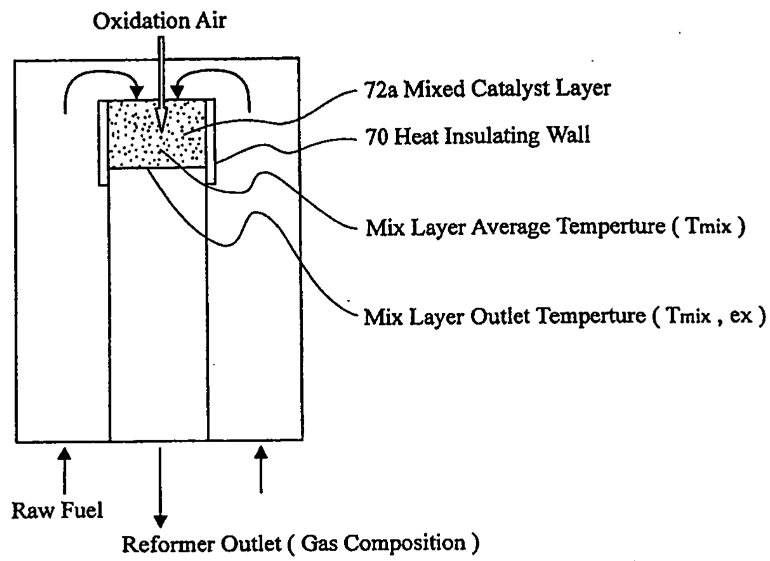
I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date August 18, 2008 By T. Kuwabara

Takeshi Kuwabara

Enc. APPENDIX I

# APPENDIX I




Experimental Verification of Thermal Effect of Heat Insulating Wall

| Model / Heat Insulating Wall | | Base Machine Without Heat Insulating Wall | Improved Machine With Heat Insulating Wall |
|---|---|---|---|
| Date of Experiment | | 2001/12/20 | 2003/2/24 |
| Place of Experiment | | Hatano Works at T.RAD Co., Ltd. | |
| Experimented by | | Takeshi Kuwabara | Takeshi Kuwabara |
| Experimental Conditions | City Gas (ml/min) | 4.2 | 4.2 |
| | Oxidation Air(ml/min)<br>Air-to-Fuel Ratio | 10.9<br>2.6 | 9.2<br>2.2 |
| Experimental Results | Tmix ( Average , ℃ ) | 741 | 747 |
| | Tmix,ex ( outlet , ℃ ) | 629 | 651 |
| | Reformed Gas Composition (mol%) $H_2$ | 49.2 | 50.5 |
| | $CH_4$ | 2 | 0.7 |
| | Thermal Efficiency of Reforming (%-LHV) | 80% | 85% |